RESEARCH REPORT NO. 25

# OCCUPATIONAL ANALYSIS FOR HUMAN RESOURCE DEVELOPMENT

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Research Report No. 25

OCCUPATIONAL ANALYSIS FOR HUMAN RESOURCE DEVELOPMENT:

A Review of Utility of the Task Inventory

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## Purpose

A review of the issues concerning the field of occupational analysis is undertaken in this paper in order to indicate the comparative strengths and weaknesses of the task inventory. Specifically, the significance of the task inventory (TI) will be assessed for:

1) reliability and validity

2) job analysis and evaluation

3) occupational restructuring and career ladder development

4) manpower planning

The organization of this report follows topic headings very closely so that the reader may quickly move to those areas of particular interest. However, the intention of the report is to provide context to the field of occupational analysis while indicating how the TI fits within this field. Thus, the history and evolution of occupational analysis is treated chronologically in order to better place the TI's significance.

## Historical Perspective

Exhibit 1 is titled the Geneology of Work Design and is found in Davis' Design of Jobs (1972). Since the Industrial Revolution, three broad areas of work

design are traced.  They are the engineering approach,
job content, and role content approaches.  As generic
types, they describe the philosophies that support the
various techniques of occupational analysis.  Interest-
ingly, these three approaches all focus on task defini-
tion and measurement.

(Exhibit 1, about here)

Most systems now used for describing men and work
reflect diverse purposes for which they primarily were
developed.  One generic category reflected in Exhibit 1
is engineering methods, e.g., time and motion study and
industrial production analyses principally devised to
improve efficiency.  Engineering methods have brought
to bear precise techniques for lay-out and measuremeht
of work stations and for the development of standards of
human performance.  By and large, engineering systems
were designed for detailed analysis of job segments or
fixed processes in a highly replicative context.  By
contrast, most ongoing manpower planning requires full
job coverage in changing environments with periodic up-
dating over time.  Why?  There is a chemistry that occurs
in the interaction between the worker and the job that
continues to influence both.  Also, after work has been
described, one or more employees leave or are promoted.
At that time, tasks which make up the work position go

EXHIBIT 1

Engineering          FJA   or   TI

Genealogy of work design
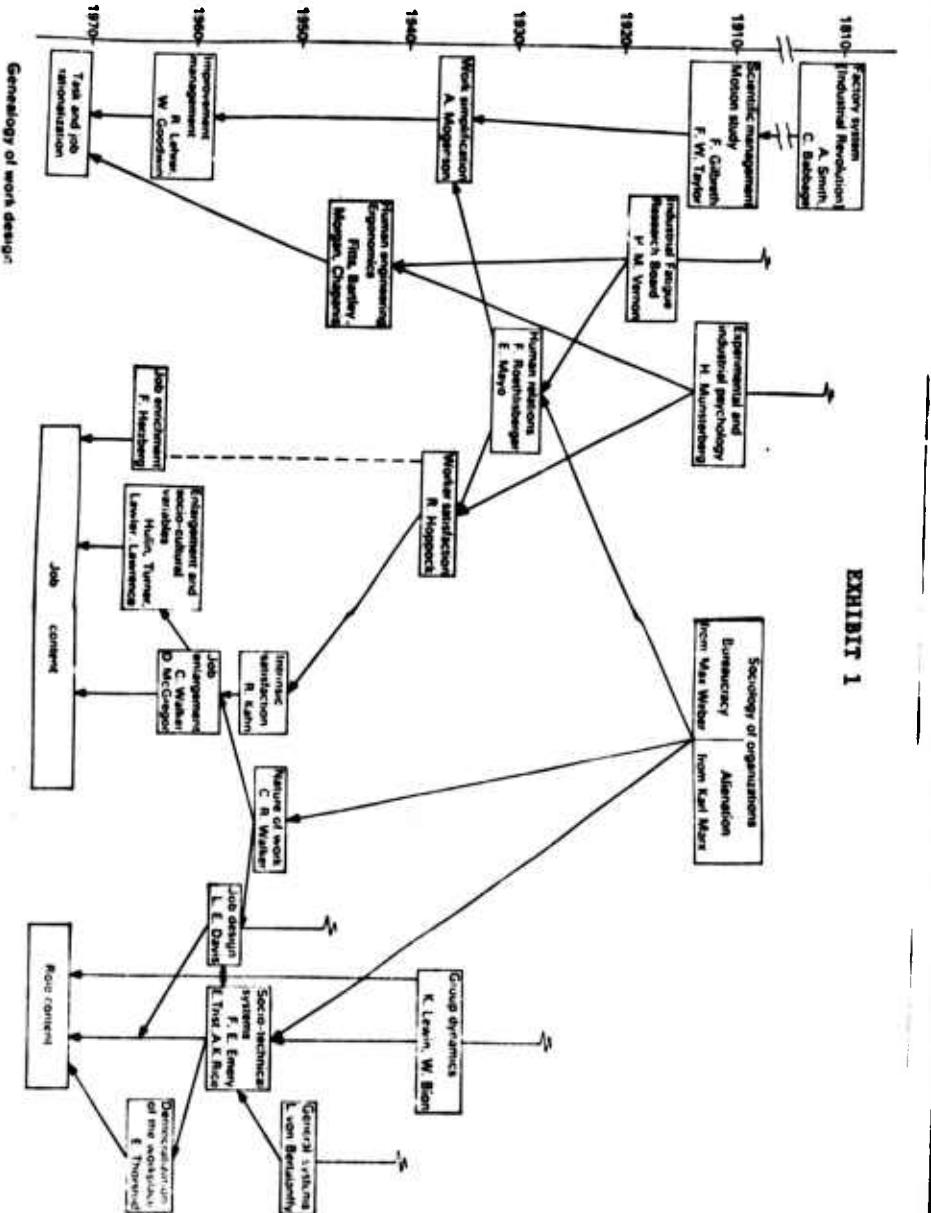


Source: Davis, Louis and Taylor, James C., Editors, Design of Jobs, selected readings: Penguin, 1972

through a redistribution process with the remaining job incumbents. Both the vacant position and those still manned may be materially changed. Extensive re-analysis, in manufacturing environments, is rarely possible with engineering methods. While they have a long history, engineering techniques are time consuming and costly.

A second broader and less precise category of occupational analysis can be collectively defined as Functional Job Analysis (FJA). This system can support either job content or role content schools reflected in Exhibit 1. FJA systems have a common methodology; usually requiring an observer called a position analyst. The resultant FJA work description is designed to cover the full scope of the job, but at a level of relatively less detail. The amount of detail lost in FJA depends on the particular system used. The U. S. Department of Labor uses the Dictionary of Occupational Titles (DOT), a highly aggregated system. The Canadians use the Canadian Classification Dictionary of Occupations (CCDO), a similar system. Other systems, such as E. J. McCormick's Position Analysis Questionnaire (PAQ), may be quite detailed, particularly respecting environment and supplementary factors-- but still does not approach the performance detail of engineering/efficiency techniques. There are many examples of FJA. Regardless of the FJA variant employed, no two position

analysts classify the same job the same way. Also, as
with the engineering techniques, standardization or quanti-
fication to permit comparisons at definitive levels of
man/position interaction are virtually impossible. The
most broadly based FJA system is the DOT in the U. S.
and the CCDO in Canada.

A relatively new system has emerged over the past
decade. It merits high confidence from 15 years of
U. S. and Canadian Armed Forces testing across a very
large range of skills distributed. This is the time-
ordered, task inventory, survey system. To begin with,
a task inventory is constructed. It lists all signifi-
cant tasks performed by workers in a given occupational
area--the job family or career ladder. A career field
is a grouping of occupational specialities involving
basically similar knowledge and skills. A career field
ladder (or career ladder) is a vertical arrangement of
occupational specialities within a career field sub-
division to indicate skill distinction and progression.
The terms career field, job family, and occupation
express the same generic concept of closely related
skills and tasks. These tasks are compiled from every
available source of occupational information. Specific
resource material may include previous position descrip-
tions, expert opinion, trade manuals, training programs,
school curricula, etc. The structure of task statements

is carefully worded to be readily intelligible to workers at the operational level. This structuring of task statements permits economic, standardized, self-reporting by direct survey of all workers or large samples of workers. These surveys further include simple but definitive measures of <u>relative time spent</u> performed on each task in comparison to total time spent on all other tasks. Each worker and each position thus becomes identified by a unique subset of work task behaviors which are weighted by relative time spent on each task. All occurences, and any combinations, of like tasks can readily be identified across all workers and positions in the same occupation.

Computer analysis based on the above cited properties can explicitly identify and systematically relate task level behavioral work requirements for all workers and all work within a given occupation. The analyses lead to comprehensive assessments covering selection, training, assignment, upgrading, evaluation transfers, and job structuring and certification. Such quantifiable data can be collected, stored, manipulated, analyzed, and reported by automated systems. These capabilities--lacking in previous systems of occupational analysis--make possible a new order of magnitude of manpower analysis planning and management. The standard software is currently available to anyone and is designated <u>Com</u>-

prehensive Occupational Data Analysis Programs (CODAP).
Structuring of data and of compuational logic in
CODAP will be schematically illustrated later. Repre-
sentative surveys are attached. Also, representative
analyses are enclosed. Actual field data collection
would include individual social security numbers per-
mitting correlation with all background data in regular
personnel files. Individual attitudinal data and other
special responses can be included to meet specific re-
search requirements, e.g., job satisfactions and per-
ceived utilization of ability.

## State-of-the-Art Methods

Given the historical background of job analysis,
what is the current state of the art of occupational
analysis?

(Exhibit 2, about here)

A recent survey by Jones & DeCoths is excerpted
in Exhibit 2 - Survey of Job Analysis. The size of
their sample was 1,805. 50% responded. Their responses
are broken down in Exhibit 2. The most common method
of job analysis breaks into the areas interviewing -
either panels of supervisors or workers. Sometimes
observation and documentary information are used.
Roughly 21% of the sample utilized checklists of tasks
and duties. To the casual reader, there are many kinds

## Exhibit 2

### METHODS RESPONDENTS USE TO
### PERFORM JOB ANALYSIS

|  | Programs for Salary-Rated | Programs for Hourly-Rated |
|---|---|---|
| Check Lists of Tasks and Duties | 19% | 23% |
| Check Lists of Worker Behavior | 2 | 2 |
| Critical Incidents | 3 | 2 |
| Daily Diary by Employee | 3 | 4 |
| Employee Written Narrative | 41 | 22 |
| Interviews | 85 | 84 |
| Of Groups | 11 | 9 |
| Of Supervisors | 79 | 78 |
| Of Workers | 69 | 61 |
| Job Training Standards Review | 2 | 3 |
| Key Question Interview | 26 | 20 |
| Observations | 57 | 72 |
| Observation-Interview | 34 | 39 |
| Old Job Descriptions | 59 | 58 |
| Questionnaires | 43 | 30 |
| Recall from Analyst's Experience | 18 | 17 |
| Supervisor-Written Narrative | 54 | 42 |
| Technical or Supervisory Conference | 20 | 17 |
| Time and Motion Studies | 4 | 13 |
| Work Participation by Analyst | 8 | 7 |
| Other | 1 | 1 |

Source:   Jones & Decoths, "Job Analysis:   National Survey
Findings," Personnel Journal 49 (10), 805-809, 1969

of methods of job analysis. Also, it is apparent that many systems of occupational analysis prevail, often in combination with each other. It is informative to review Jones & DeCoths' "Conclusions":

> Three important conclusions may be drawn from information provided by this survey. First, there is widespread dissatisfaction with present job analysis programs, particularly with respect to currency of job information and versatility for diverse purposes. The reasons for this dissatisfaction may be attributed to lack of standardized, quantifiable techniques for gathering, recording, and presenting job information, and limited use of EDP. Second, most job analysis programs are characterized by relatively little emphasis on human relations type job variables. Third, due to the rapidly growing work force, the current emphasis on upgrading the unemployed and underemployed and the impact of technological change on the natur. of work, the traditional techniques of job analysis may no longer be adequate to meet the needs of the economy.

> These conclusions suggest the need for a two-pronged research effort in job analysis. One aspect of the research should attempt to develop a comprehensive model for improving job analysis procedures. The objective of this research should center around quantifying job information, increasing its validity, eliminating its subjectiveness, and reducing the costs of its collection. In addition to standardizing job job analysis methods, the successful implementation of such a model will greatly facilitate updating of job information. The other aspect of the research should examine ways to help job analysis practitioners define and measure psychological and sociological job related variables. Increased availability and validity of human relations type job data will enable manpower managers and planners to more effectively deal with the human aspects of technological change.

The state-of-the-art methods, as this survey shows, reflect dissatisfaction with methods of the past. Up to date, accurate job information is needed by these organizations. Currently, they do not get this. Standardizable, quantifiable techniques which adapt to the computer are needed. Currently, they are not in use. Higher standards of reliability and validity are required, and a call for research is issued. Fortunately, this review only points out that diffusion of technology is slow because most of the problems raised have been solved. A comparative evaluation of the new state-of-the-art argues this case.

## Comparative Analysis

In order to analytically place into perspective these various methods of occupational analysis, Exhibit 3 was created.

(Exhibit 3, about here)

Exhibit 3 cross tabulates common attributes of occupational analysis systems with three of the most common generic systems. That is, Exhibit 2 may reflect many diverse methods of occupational analysis, but they are organized into three gross categories. Of these three categories, two are now hybrids as computer assisted systems.

Exhibit 3

## COMPARATIVE ATTRIBUTES OF OCCUPATIONAL ANALYSIS SYSTEMS

| Attribute of System | Manual Systems | | | Computer Assisted Systems | |
|---|---|---|---|---|---|
| | Engineering Job Analysis | Functional Job Analysis | Check List Job Analysis | JAV - DECAL FJA | CODAP Task Based, Time Ordered |
| Measurement: Specificity & accuracy | VG | F - G | F - VG | F | VG |
| Generalizability | P | P | F - VG | P | VG |
| Relative Cost | Very costly | Costly | Economical | Relatively Economical | Economical |
| Relative Speed & capacity | Very slow & very limited | Slow & limited | Slow & high capacity | Slow to Fast(a) & high capacity | Fast & high capacity |
| Exhaustiveness | F | F | F - VG | F | G |
| Utilization of Product: Qualification standards development | G (limited) | F | F | F | EX |
| Job engineering | EX | F | F - G | F | EX |
| Manpower Planning | F | F | F - G | F | EX |
| Career Ladder design | F | F | F - F | F | EX |
| Performance evaluation | P - G | P - F | F - G | P - F | EX |
| Curriculum development | G - VG | F | P - F | P - F | EX |
| Job Pricing. Evaluation | G | F | F | F | EX |
| Overall Utility | Average utility | Limited utility | Limited utility | Limited utility | High potential Needs testing in all applications |

(a) both JAV and DECAL are experimental

A general discussion of the attributes of <u>any</u> occupational analysis system is in order.

<u>Measurement</u>: information or data collected must be in form that is understandable to others. It should be specific, discrete, and accurate.

<u>Generalizability</u>: since data collection is expensive, we would like to get the maximum mileage out of our efforts. Therefore, accuracy of measurement combines with the amount of information collected to give us a basis for generalization: naturally, we would wish to be confident about our generalizations.

<u>Relative Cost</u>: any occupational analysis system costs time and money. What are the goals? How many dollars are needed to achieve this objective? Some systems are extremely costly because so much high salary is tied to these systems, e.g., the engineering approach. Cost can never be overlooked. At times, it is the one deciding factor when totaling up the strengths and weaknesses of the other attributes.

<u>Relative Speed and Capacity</u>: many occupational analysis systems are slow to produce meaningful data. In fact, the layman often confuses the method of collecting job data with the type of analysis because the method is visibly slow, e.g., observation, interview, daily diary, critical incidents, etc. So much time is taken in collecting data <u>that</u> <u>this</u> <u>time</u> <u>is</u> <u>only</u> <u>exceeded</u>

by the time necessary to analyze it.  Thus, relative
speed is slow with most manual information systems.
This slow relative speed interacts with capacity
because the slower the speed with which job infor-
mation can b, collected and analyzed, the lesser the
capacity of the system to store up to date, comprehen-
sive job analyses.

Exhaustiveness:  the completeness of occupational
measurement is always in question - especially in large
manpower applications.  For example, certification of
a given trade across regions of the country requires
an occupational analysis which is sufficiently compre-
hensive across all regions.  Not only that, it should
be comprehensive enough to describe cyclical or seasonal
variations in occupational content.  Therefore, a good
measurement of occupational content is only as good as
it is exhaustive.  And clearly, this increases generali-
zability while increasing costs!  Some optimal combina-
tion of these attributes reflected in Exhibit 3 is
clearly preferred.

Utilization of Product:  each possible product of
occupational analysis is assessed against the type of
analysis system.  This judgment is aggregated at the
bottom of the table.

The attributes of Exhibit 3 are explained above
and a discussion follows in the next section based on
the comparative evaluation of each generic occupational
analysis system with each of these attributes.

## Engineering Approach

The aggregate assessment of the engineering approach
to occupational analysis indicates average utility.
Specifically, measurement can be very good. Generali-
zability is clearly poor as job samples are always small,
though based on work sampling. Cost is usually high
since industrial engineering is a costly staff function.
Relative speed of the engineering approach is slow. It
is a one-on-one observational technique. The capacity
of the technique is limited because of the requirement
for observation. Exhaustiveness is poor because the
technique is limited to idealized work factors - usually
in an industrial environment. There are other considera-
tions that make the engineering approach less useful for
qualification standards, manpower planning, and perfor-
mance evaluation. However, job engineering and some train-
ing applications are well handled by this method.

Per Gilpatrick (1973), industrial engineers, in
dealing with staffing problems and efficiency, use job
analysis. They evaluate the workers' relationships to
machines and work flows. By definition, the unit of
work is tied to existing technology. These approaches
do not require reliable task definitions. Concerning
this lack of scientific rigor:

...heuristic descriptions may aspire to the
rigorous characteristics of scientific de-
scription (but)...may be satisfied with much
less.... Task analysis at present is a heu-
ristic description of activities at the func-
tional interface of the human operator and the
objects and environments with which he inter-
acts. As such, its value is proportional to
its utility and economy in the design, evalua-
tion, and operation of systems....

(Miller, 1966; p. 188)

Miller's definition of a task is:

A group of unitary human operations having a
common purpose, directed towards the same speci-
fic output(s), and usually occurring at about
the same time or in close sequence...

(Op.cit., p. 13)

The use of the term "operator" by engineers,

rather than "performer" in the definition presented

below reflects this lack.

1.  The task contains an explicit goal which
    identifies for the operator the state or
    condition to be achieved as a result of
    task performance.

2.  The task contains input stimuli represen-
    ting sources of information external to
    the operator but to which he must attend
    if the goal is to be achieved.

3.  The task contains a set of procedures
    which specify particular responses to be
    made to the input stimuli during task per-
    formance.      (Op.cit, p. 44)

Perhaps, the most sophisticated engineering defi-

nition may be that of Verdier (1960). However, it

also shows the inherent problems, Verdier defines a

task as:

> A limited and orderly grouping of individual
> human activities applied methodically to
> things or equipment for the purpose of satif-
> fying some problem or need.

To clarify the definition; human activities in
tasks are generally, but not always, limited to
those performed by one individual within a con-
venient period of time, usually less than one
day.  These activities are orderly, in that
they are grouped in a homogenous manner with an
observable start and completion stop.  The task
is comprised of elements; these are simple, dis-
crete responses which are carried out in a cumu-
lative and progressive sequence.  Task activities,
or elements, are usually applied to, or concern,
specific things or equipment.  The things that
task activities are applied to should be mentioned
in the description of the task; as example:  cali-
brate a voltage meter, adjust a carburetor, ship
a container, counterbore a support bracket, etc.
The purpose and activity of the task should also
be inferred as a verb in the task description;
this clarifies the problem or need for which the
task is performed.  In the case of the short tasks
we have just mentioned, these verbs are:  calibrate,
adjust, ship, and counterbore, respectively. (p. 37).

In relating the task to its component elements, Verdier

expands on the definition; the orientation to blue collar

work is quite apparent:

a.  The element whould be the most simple form
    of discrete activity within the task, a
    single stimulus response act, if possible.

b.  An element should contain the smallest ob-
    servable, continuous, integrated, activity
    within the confines of one central idea,
    as example; "Remove container cover."

c.  Elements are reflective of the smallest
    coherent action relationship between the
    human and the equipment.

d.  The element should have an observable start
    and a completion stop.

e. The central idea of what is to be done within the task element should not only be clear, but should be defined on the worksheet as concisely as possible by some commonly understood verb. As example; "Remove the cover," "Read the gauge," "Insert the gasket."

f. If a single element accomplishes a task, the element may then be the task.

g. Elements are best presented on the task analysis worksheet in a logical, numbered sequence, in exactly the same order that these are carried out in the best performance of the task.

h. There should be a minimum of overlapping of the same elements within the total task breakdown.

i. Elements are best worded in the present tense, second person, and should start with an action verb; there may be exceptions, however.

j. Each element should contain some actual, observable activity; something the performer does.

Examples: thinking about what to do is not an observable activity. Looking, inspecting, or perceiving, by itself is not an observable activity. Observing meter reading 275 lbs. is an observable activity. Waiting by itself is not an observable activity; however, waiting until the gauge reads 275 l s. is an observable activity, as it contains a start and completion stop. (p. 41).

This excerpt gives a flavor of the engineering approach and its concern with task as a unit of measurement in job analysis. In practice, however, the engineering approach is used primarily to derive work factors and standard costs in manufacturing. Thus, the aggregate assessment of the engineering approach is that it has average utility. This is based on the lack of utility and extension of this method to other products of occupational analysis.

## Functional Job Analysis

Functional job analysis (FJA) is the major, generic form of occupational analysis. Generally defined, FJA describes what gets done and what the job incumbent does. How these two processes are the be logically captured depends upon the particular system of FJA employed. Thus, what gets done refers to technology that can be categorized into work fields. What the worker does refer to the worker's physical/mental activities that can be categorized into worker functions.

As Exhibit 3 indicates, however, its measurement properties are fair to good - depending on its applica-tion. This is due to FJA requiring training in some system of classification and semantics. That is, if Fine's FJA (the DOT and CCDO system) is employed, his definitions of keywords are essential. Also, like all taxonomies, the classification systems that support FJA's smooth over real differences within and across occupations. Thus, measurement suffers.

Generalizability is poor because of the measure-ment properties of FJA. The true variation in occupa-tional content is always difficult to capture, but superimposing categories on this variation is illogi-cal because the categories equalize this variation.

Users of the DOT have been aware of this deficit for sometime.[1]

Relative cost of FJA is high - if the system is to be maintained. Sometimes the cost is low because FJA is attempted in cycles. That is, a job family is described and years pass before this effort is mounted again. Here, of course, low cost is associated with stale occupational data. Conversely, if FJA is maintained, the cost is high since full time occupational analysts are required to apply FJA techniques.

Relative speed and capacity; the techniques are faster, in some cases, than engineering techniques, but still rely heavily on observation and interview (see Exhibit 2, as a reminder of the various methods of data collection employed). The capacity, of course, is linked to the method of classification found in the DOT. Over 3C,000 jobs are listed! Users must be trained in the logic of the classification system and be wary of constantly changing job descriptions which cannot be found in the DOT.

---

[1] A useful exercise to test this assertion is to look up carpenter (construction) 860.381 on page 101 of DOT (1965, 3rd ed.) All general carpenters may be able to perform the tasks listed, but none do all of them in their jobs. The mix of tasks, their frequency, skill level, etc. do not exist in DOT descriptions - which are overly general.

As to exhaustiveness, some FJA methods are exhaustive
(e.g., the Position Analysis Questionnaire of E. McCormick).
The PAQ has six dimensions for describing work and is unique
among the FJA systems. Usually, however, FJA systems employ
some variation of Fine's three dimensions which are illus-
trated in Exhibit 4.

(Exhibit 4, about here)

This scheme of data, people, and things is well known
since it is one of the bases of classification used in the
DOT. These three dimensions are scaled into functional
levels and have precise definitions for each functional
level. For example, statistical clerk interacts with data,
but the functional level may only be comparing and check-
ing. This carries a medium code level as depicted in
Exhibit 4. Conversely, a professional statistician may
interact with data by synthesizing data arrangements.
Therefore, this functional level carries the highest code
level in this scheme. The same occupation is classified by
its functional level on the other two dimensions. In fact,
the six digit code for the two occupations are 216.388 (clerk)
and 020.188 (statistician). The difference in functional
level of interaction is designated by the fourth digits in
each code (3 and 1, respectively). These levels require care-
ful definition. The training of the occupational analyst
must be uniform to guarantee that they are applied consistently.
For example, here are the definitions which support just
one dimension of the data, people, things scheme:

## Exhibit 4

### Scales for Controlling the Language
### of Task Statements

*Summary Chart of Worker Function Scales*
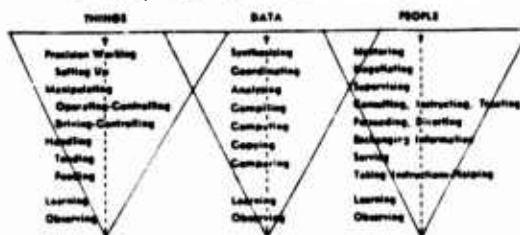


| LEVEL | DESCRIPTION | LEVEL | DESCRIPTION |
|---|---|---|---|
| 1 | **COMPARING** Selects, sorts, or arranges data, people, or things, judging whether their readily observable functional, structural, or compositional characteristics are similar to or different from prescribed standards. | 5A | **INNOVATING** Modifies, alters, and/or adapts existing designs, procedures, or methods to meet unique specifications, unusual conditions, or specific standards of effectiveness within the overall framework of operating theories, principles, and/or organizational contexts. |
| 2 | **COPYING** Transcribes, enters, and/or posts data, following a schema or plan to assemble or make things and using a variety of work aids. | 5B | **COORDINATING** Decides time, place, and sequence of operations of a process, system, or organization, and/or the need for revision of goals, policies (boundary conditions), or procedures on the basis of analysis of data and of performance review of pertinent objectives and requirements. Includes overseeing and/or executing decisions and/or reporting on events. |
| 3A | **COMPUTING** Performs arithmetic operations and makes reports and/or carries out a prescribed action in relation to them. | | |
| 3B | **COMPILING** Gathers, collates, or classifies information about data, people, or things, following a schema or system but using discretion in application. | | |
| 4 | **ANALYZING** Examines and evaluates data (about things, data, or people) with reference to the criteria, standards, and/or requirements of a particular discipline, art, technique, or craft to determine interaction effects (consequences) and to consider alternatives. | 6 | **SYNTHESIZING** Takes off in new directions on the basis of personal intuitions, feelings, and ideas (with or without regard for tradition, experience, and existing parameters) to conceive new approaches to or statements of problems and the development of system, operational, or aesthetic "resolutions" or "solutions" of them, typically outside of existing theoretical, stylistic, or organizational context. |

These definitions appear clear, but in practice there is much variance in their application.

Therefore, when we sum up the attributes of the FJA system per Exhibit 3, we evaluate FJA as having limited utility.  It is probably best as a manpower labor exchange system.  There appear to be better methods available currently, however, and FJA offers little help for other products of occupational analysis - especially job pricing or evaluation.

Nevertheless, as this paper has maintained, the task is a common unit of measurement spanning all of the generic systems reflected in Exhibit 3.  For that reason, it is helpful to review how Sidney Fine (Fine et al, 1974) views task:

### Conceptualization and Definition of Tasks

In FJA a basic distinction is made between what workers do and what gets done - between behavior and end results.  This distinction is carried into the methods of analysis (data gathering) and the formulation of the Task Statements.  The distinction has been essential since, historically, most job descriptions dwelt primarily on what got done.  Another key concept or assumption of FJA is that Task Statements, while certainly not the reality of work activity, are as close to that reality as you can get to carry out personnel operations.  Task Statements are verbal formulations of activities that make it possible to describe what workers do and what gets done so that recruitment, selection, assignment, training, performance evaluation, and payment can be efficiently and equitably carried out.  Therefore, the focus of our attention must be on the formulation - the words and the organization of words in the Task Statement used to express the task.  The formulation must stimulate reality; that is,

those performing the task must agree that, insofar as the task can be communicated, the Task Statement does so. Furthermore, since a task is part of a context; namely, a work situation, it is essential that the language of one Task Statement be compati-'le with that of other Task Statements in that context and that together they can describe the technology of a work situation. For practical purposes, then, the Task Statement is the task.

In FJA a task is defined in terms of a controlled language, a controlled method of formulation, and in relation to a systems context. The definition is as follows:

> A task is an action or action sequence grouped through time designed to con-tribute a specified end result to the accomplishment of an objective and for which functional levels and orientation can be reliably assigned. The task action or action sequence may be pri-marily physical, such as operating an electric typewriter; or primarily mental, such as analyzing data; and/ or primarily interpersonal, such as consulting with another person. (Fine & Wiley; 1971:10)

Tasks conceived and formulated according to this definition have permanence that jobs and assignments of everyday parlance do not have. Although mutable, tasks can and will become building blocks in personnel practice and manpower planning. Hence, it is important to formulate and edit Task Statements carefully.

A task formulated according to FJA methodo-logy becomes the most fundamental unit of a work-doing system. From it, it is possible to make reliable and valid inferences about the worker, the work organization, and the work.

The Worker. The worker's functional level and orientation are indicative of his experience, education, and capability to perform the task.

The Work Organization. The methodology provided for and the output of the Worker Actions must contribute to the Objectives of the organization.

The Work. The action, object of the action, equip-
ment provided, and output are indicative of the
Performance Standards and Training Content (both
Functional and Specific), as well as the basic
skills in reasoning, math, and language required.

The logic of Dr. Fine's words is clear and precise,
but, again, application depends on trained personnelists
understanding and applying this logic in a standard, uni-
form way.

An extension of this discussion on FJA is to review
how the U.S. Department of Labor (1973) views this same
unit of measurement (the task) within the FJA framework:

## U.S. Department of Labor

(Tasks are the) distinct major activities that
constitute logical and necessary steps in the
performance of a job. (BIPP 152-35: p.11)

(A task or duty is) made up of one or more ele-
ments.... It is the work unit that deals with
the methods, procedures, and techniques (the
"what," "how," and "why") by which parts of a
job are carried out. A task or duty is created
whenever human effort, in terms of one or more
elements, must be exerted for a specific purpose.
The effort may be physical, as pulling and lift-
ing, or mental, as planning and explaining. The
effort may be exerted to change a material. The
material may be tangible, as boards and nails, or
intangible, as numbers and words. Each task or
duty has certain distinguishing characteristics.

(a)  It is recognized, usually, as being one
     of the worker's principle responsibilities.

(b)  It occupies a significant portion of the
     worker's work time.

(c)  It involves work operations which utilize
     closely related skills, knowledges, and
     abilities.

(d)  It is performed for some purpose, by some
     method, according to some standard with
     respect to speed, accuracy, quality, or
     quantity.  This standard may be provided
     by the worker himself through trial and
     error or as a result of experience; it
     may be furnished to the worker by his super-
     visor in the form of oral, written, or gra-
     phic instruction; or it may exist in the
     form of directives, published operating pro-
     cedures, or similar media.

(An element is) the smallest step into which it is
practicable to subdivide any work activity without
analyzing separate motions, movements, and mental
processes involved.  It is a work unit that describes
in detail the methods, procedures, and techniques
involved in a portion of a job. (p. 6)

However, the investment decision tends to rationalize

itself to the point that newer (perhaps more parsimonious

and efficient) systems are available.

Summing up the comparative attributes of FJA, its

primary purpose was for man/job matching and it does

that adequately.  Overall, however, it is judged to

have limited utility for the other uses of occupational

analysis even though it is probably the prevailing method.

## Checklist Approach

As the Jones & DeCoths survey shows (Exhibit 2),

the checklist was employed by some 20% of the organizations

surveyed.  Per Beach (1975), the checklist method is of

value in large organizations wherein large numbers of

people are assigned to similar jobs.  Some staff group,

or panel of experts must prepare the checklist for each

of the various job families in a given organization.

The usual methods of preparation are employed (observation, interview, previous documentation, etc.). After the checklist is constructed, it is administered to the job holders. They merely check off whether they perform the task. They may be asked to indicate their proficiency, training, and experience also. They may be asked to write in additional tasks not seen on the checklist.

According to Morsh, Madden, and Christal (1968):

A number of problems are inherent in the checklist method. Information about the sequence in which tasks are performed by an incumbent or the relationships among tasks is not obtained. It is also sometimes difficult to write task statements to which an unequivocal response can be given. For instance, in the case of tasks which are shared as a two-man or crew tasks, incumbents' responses may be ambiguous with respect to the performance of specific work activities within the task. Task statements are not always mutually exclusive. Some statements overlap or are included in other statements. Tasks are not homogeneous. Several activities that are invariably performed together by one man may at times be legitimately combined as a single task statement. On the other hand, a relatively small segment of behavior may appear as a separate task if it is performed independently of other work activities. The scope of the task statement depends upon the judgment of the checklist constructor. Although it is structured, if the checklist is lengthy, the tedium of completing it may arouse disinterest and low motivation with consequent unreliable responses. Unless the items are grouped into meaningful categories, such as duties, it is virtually impossible to gain an overall perspective of the job from checklist information alone.

Nevertheless, the checklist has many decided advantages. The checklist requires recognition on the part of the incumbent rather than the less de-

pendable recall which is essential to some of the other methods. The checklist makes possible group administration to large samples of incumbents, thus making occupational data available rapidly and economically from widely representative populations. The responses are adaptable to machine tabulation.....

Measurement: the checklist approach always had appeal because of its survey characteristics. Nevertheless, measurement is fair to very good depending on the specificity of the task statement construction. Indeed, some checklists check of knowledges, job elements, or just duties.

Generalizability: due to its survey characteristics again, the generalizability of the checklist method can be very good. But, for the deficiencies cited above generalizability depends greatly on the technique and care of checklist construction.

Relative cost of the checklist; even before machine tabulation was invented the checklist was economical for the amount of data acquired. Whereas the same amount of time for an occupational analyst is required to produce a checklist, this is usually offset by the large number of job incumbents that can be reached with this method.

Relative speed and capacity; the checklist method is unusually different from the engineering and FJA approaches (see Exhibit 3). That is, relative speed of checklist development is as slow as the other two approaches

are, yet the checklist has high capacity. This high capacity is again due the exhaustiveness that can be built into a checklist plus the surveying of large numbers of jobs.

Exhaustiveness, as mentioned, can be very good. As we shall see, the craft of constructing a comprehensive checklist requires careful attention to technique. Thus, the checklist approach has the capability of exhaustively describing many job families if care in its construction is manifested.

Unfortunately, the aggregate assessment of the checklist method is judged to have only limited utility overall. Primarily, this judgment is based on the very wide range of measurement and technique that has gone into this approach. There have been no standards for the checklist approach. However, through the years it has had a steady attraction for the more systems-oriented personnel researchers. The U.S. Air Force pioneered in this area and has contributed over 100 studies on various facets of this approach. Some of these, and the work of others in the field, will be reviewed below. It is important to cite why the checklist evolved at this point, however. A breakthrough in statistical analyses and methodology took advantage of the better properties of the checklist. The properties claimed are:

1)  simplicity

2)  standardizability

3)  quality work information (for many types of
    occupations)

4)  currency of job information (due to low cost,
    survey techniques)

5)  broad sampling

6)  economical

7)  product of survey has many uses

8)  procedure is flexible

These are broad claims.  The remaining portion of
this paper reviews the evidence for task based, time
ordered occupational analysis.

The JAV and DECAL computer assisted FJA approaches
will not be dealt with.  These two systems are still
experimental.  They are both examples of a wedding of
computer speed with faulty measurements.  That is, FJA,
as a system, has inherently poor measurement and relia-
bility problems when compared to the checklist approach.
Therefore, computerization of FJA increases some of its
uses and speed, but does not overcome the inherent pro-
blems of FJA.

Our discussion prefers, instead, to review the empi-
rical research of the past 15 years on the task based,
time ordered system of occupational analysis - the TI.

## The Task Inventory and CODAP

The carefully constructed TI produces data that can be analyzed with correlation, cluster analysis, and crosstabulational techniques.  How?  The great step forward was to attach a variable to the task statements which had meaning to the job incumbents and was scalable for statistical analyses.  After considerable testing of absolute time (via time diaries) percent guesstimates (via reconstructions of proportions of time spent in functional areas), a simple rating scale which assesses relative time spent became the best candidate.

## Relative Time Spent

Research considerations into proportional time estimates tied to task led U.S. Air Force researchers through many tests.  Here is a partial recounting of their empirical experience from Morsh, et al:

> The incumbent may make a direct estimate on an absolute scale which expresses the proportion of total working time spent on each task, or he may make a judgment of time spent on each task relative to the other tasks he performs.

> In a series of limited pilot studies, some absurd results were obtained when absolute estimates of proportion of time spent on each task were required.  As an illustration, in one sample of ten incumbents, the total proportion of time estimates ranged from 400 per cent to 2300 per cent.  The difficulty seems to be in breaking up 100 per cent or total time spent into individual percentage estimates for all the tasks on the inventory.  One alternative is to obtain relative estimates such as average, more than average, less

than average, and the like.  Whether this method
merely obscures the difficulty or allows the in-
cumbent to make judgments of which he is more
capable is difficult to determine.

Another method for obtaining measures of
proportion of time spent on each task is to re-
quire the incumbent to estimate the frequency
with which he performs each task and the length
of time which he takes to perform each task.
These ratings are then cross-multiplied to pro-
vide proportion of time estimates.  In a series
of exploratory studies, when absolute scales
were used to obtain judgments such as times per
day and minutes required, results were rather
erratic.  There is some evidence that incumbents
in the higher aptitude brackets are able to make
these responses accurately and consistently,
especially if few tasks are performed.  On the
other hand, incumbents in the lower aptitude
levels tend to produce extremely variable re-
sults.  If relative scales are used to obtain
both frequency and time-to-do judgments, satis-
factory results appear to be attainable from
incumbents in all specialties.

....a relative proportion-of-time-per-task
scale was used by Ammerman.  His five-interval
scale required incumbents to judge each task
from "least" to "most" amount of time needed
for task performance in relation to all other
tasks done.  He also obtained proportion of time
estimates by combining frequency and absolute
time scales.  In this case, the relative scale
was less consistent and failed to duplicate the
combination of the absolute time and frequency
scales.  However, whether or not tasks were per-
formed was reported more reliably with the rela-
tive scale.

Using an Inflight Refueling specialty task
inventory and a sample of 31 incumbents, Madden
attempted to evaluate three relative type rating
scales in terms of the number and kinds of errors
made and the distribution of responses.  The rela-
tive proportion of time for each task was computed
by combining responses to frequency and time-to-
do scales, each with five categories.

He found that with these scales incumbents in
this sample exhibited almost no tendency to make
omissions, off-scale entries, or other mechanical
errors. He consequently judged all the scales to
be highly satisfactory in this respect. Madden
found also that incumbents' mean ratings were lo-
cated approximately in the middle of the scales
and that the means for each scale were symmetri-
cally distributed across the entire scale. The
standard deviations tended to be small which indi-
cated a rather infrequent use of the extremes of
the scales.

These early Air Force studies are also indicative

of efforts other researchers were doing. Stogdill and

Shortle (1955), Mahoney, et al (1963), and Hinrichs (1964),

pursued proportional time measures of job content. Results

were mixed, depending on specificity of job content mea-

surements. However, Carroll and Taylor report an average

correlation of .88 of all respondents between time alloca-

tions of estimates and absolute work measurements (via

job sampling).

At the same time, Air Force research was testing

experimental scales for obtaining estimates of time spent

on each task. Ammerman tried "time" scales providing for

open-ended responses. It was reported that these responses

clustered on certain values - perhaps caused by a rounding

tendency. A revision of this research was attempted and

Madden reported that:

Revised scales were then constructed in which
frequently used values represented points along
a continuum. For example, the resulting "time-
to-perform-a-task" scale listed less than 1 minute,
1, 2, 5, 10, 20, 30, 45, 60, and 90 or more minutes.
This method of determining scale values seemed to
have some advantage over the logically constructed
scale which includes class intervals with specified
mutually exclusive limits. On another scale incum-

bents were asked to report "amount of time spent"
to the nearest percentage value, (i.e., less than
1%, 2%, 3%, 5%, 10%, 15%, 25%, more than 25%).
As might be expected, over half of all responses
were in the category, "less than 1%," giving little
discrimination among tasks.  (1961)

Since reporting "amount of time spent" to nearest

percentage value produced not enough discrimination for

the Air Force, they tested "length-of-time-of-task-per-

formance."  Scales assessing this variable were categorized

into two absolute modes.  That is, 10 and 20 minute cate-

gories were provided for in the scales, e.g.,

1)   scale values = -1, 2,...., 10, 15,...., 30,

40, 45, 50, 60, 90 plus

2)   scale value = -1, 1, 2, 5, 10, 20, 30, 45, 60,

90 plus

The longer absolute time scale gave greater relia-

bility in the results (r=.74).  The 10 category scale cover-

ing the same range of values produce an r. of .65.  This

result coincides with the known finding that increased

reliability is associated with greater range of response

categories.

This research of the Human Resources Laboratory of

the U.S. Air Force led to a test of the relative-time-

to-do scale that had five intervals.  These were:

1  =  very short

2  =  short

3  =  average

4  =  long

5  =  very long

This finding showed that the computed mean of each respondent's scores was distributed over the entire scale. The mean of the means was 2.9 and standard deviation .38. The interpretation of the results is that job incumbents can respond accurately to a relative scale.

This finding is crucial because the relative time spent scale was later expanded to a 7 point scale of which is presented in Exhibit 5.

(Exhibit 5, about here)

Step 2 demonstrates how the scale is presented. The explanation of the scale is psychologically real to most respondents. Test-retest studies (McCormick & Tombrink, 1960; Moore, et al, 1974) reveal reliability coefficients in the high .70's. Validation of these time spent measures has been pursued with a variety of techniques - all suggest valid use of the relative time spent rating. Consider the following evidence from Morsh, et al:

> Interviews with incumbents and with supervisors were compared with inventory responses by Strayer, Harris, & Buckner as a measure of the validity of task inventory information obtained from incumbents. In general, they found only minor discrepancies between inventory responses and interview findings.

> Results of self-administered performance reports filled out daily by bomb-navigation systems mechanics over a period of four and one-half months were compared with task inventory data in an attempt to appraise the validity of task-inventory information. The particular tasks each mechanic reported on the daily work record as performed depended to some extent upon normal rotational assignments and the shifts which he worked. Consequently, the comparison between data provided by the automatic data collection plan and data obtained from the completed task inventories

EXHIBIT 5

Each step should be performed for the full list of tasks

before proceeding to next numbered step.

```
┌─────────────────────────────┐
│ STEP 2.                     │
│                             │
│ Indicate relative time on each │
│ task in present job. Only enter │
│ time for tasks you checked on │
│ Step 1. (Time does not neces- │
│ sarily = importance)        │
│                             │
│ 1. Very much below average  │
│    time on this task        │
│                             │
│ 2. Below average time       │
│                             │
│ 3. Slightly below average   │
│    time                     │
│                             │
│ 4. Average time             │
│                             │
│ 5. Slightly above average   │
│    time                     │
│                             │
│ 6. Above average time       │
│                             │
│ 7. Very much above average  │
│    time on this task        │
└─────────────────────────────┘
```

1. Check tasks performed (✓).
   Add tasks you do which are not listed.

2. Rate checked (✓) tasks on time spent.

```
┌──────────────┐
│ STEP 1.      │
│              │
│ Check own    │
│ job tasks    │
└──────────────┘
```

| A. DIRECT PATIENT CARE | | |
|---|---|---|
| 1. Administer bladder irrigations | | |
| 2. Apply cervical traction | | |
| 3. Assist patients to turn, cough and deep breathe | | |
| 4. Brief family on condition of patients | | |
| 5. Catherize patients | | |
| Write in any additional tasks you perform. | | |
| | | |
| | | |
| | | |

-35-

was not directly comparable, since inventory
responses were single estimates covering a
fixed time period.  The average frequency of
task performance for each task was derived
from daily performance reports completed by
49 incumbents and from task inventories com-
pleted by 162 incumbents.  The resulting pro·
duct-moment correlation across 129 tasks was
.66.  The fact that the self-administered
data collection plan totals agree to this ex-
tent with the task inventory frequency ratings
is encouraging, considering the differences in
samples and data collection techniques, as well
as the changes in work assignment which took
place during the four and one-half month period.

Both reliability and validity will be dealt with more
comprehensively below.  However, the relative time spent
variable is crucial to statistical analysis.  For this
reason, this paper attempts to specify its research develop-
ment.  Careful search for a variable that is real to job
incumbents yet lends itself to statistical routines marks
this Air Force research.  The high speed of the computer
means nothing if job content cannot be comprehensively
measured and quantifiably manipulated.  Why?  The TI relies
on the job incumbent being the best source of job informa-
tion since he is closest to the work.  However, job incum-
bents write poor job descriptions.  But, the TI is the
product of the occupational analyst and permits the job in-
cumbent to provide job content through the structure of the
TI by providing valid, reliable data for computer analysis.

Thus, there are four important reasons why the TI,
as computer analyzed, is so useful for qualification stan-
dards development, training program development, occupa-

tional restructuring, and job evaluation:

1.  Accuracy of Measurement -
    The smaller the unit of description (i.e.,
    task), the more stable the description
    tends to be. Thus, the measurement is
    better than that for many other forms of
    job analysis.

2.  Comprehensiveness -
    This technique is comprehensive and yet
    economical. Data are collected from all
    employees, if need be, and not the few
    "sampled" by position analysts. Still,
    the cost is less than for engineering
    techniques.

3.  Quantifiability -
    Data collected are quantifiable, unlike
    functional job analysis.

4.  Manipulability -
    Manipulation of quantified data is simple
    via computer. Data retrieval, analysis,
    and reporting are all handled by computer,
    which is an advantage not shared by func-
    tional job description techniques.

## Comprehensive Occupational Data Analysis Programs - CODAP

CODAP is the acronym for a computer software package
which analyses task data. Currently, there are over 30
statistical routines. The most useful will be discussed
briefly, however, a greater description is available from
either the National Technical Information Service or the
Air Force Human Resources Laboratory, Lackland Air Force
Base, Texas, where CODAP was developed.

One of the most important CODAP routines is the
hierarchical clustering routine (called GROUP). Indivi-

viduals or groups of individuals can be clustered by
computing a similarity matrix. The relative time spent
data are summed for each individual, then estimated per-
cents are computed. Thus, the values of each relative
time spent variable range from 0 - 100 for tasks performed.
Therefore, the similarity matrix uses a hierarchical
grouping which involves repeated searching for those
individuals or partially formed clusters which have the
highest degree of similarity.

Each cluster is actually called a "stage." Exhibit 6
diagrammatically shows this statistical process. Cluster-
ing continues until a single group has formed. This
group will contain all individuals in a survey. There-
fore, when looking at Exhibit 6, keep in mind that Stage 1
is the last stage since the matrix compared all individuals
on all tasks according to the estimated percent of time
they performed the tasks. At this stage there is only
34% overlap among all ten surveys.

(Exhibit 6, about here)

From the Exhibit, each stage shows the degree of over-
lap by the percentage figure. For example, Stage 6 shows
individuals 43, 21, and 26 as being arrayed in 1, 2, 3
order. The time spent on similar tasks overlaps by 92%.
The order that individuals 43, 21, and 26 were clustered
becomes valuable because the sequence of 1. 2, 3, etc.,
indicates how close each person's work is to another's.

Exhibit 6

BRANCH DIAGRAM OF JOB GROUPING SEQUENCE
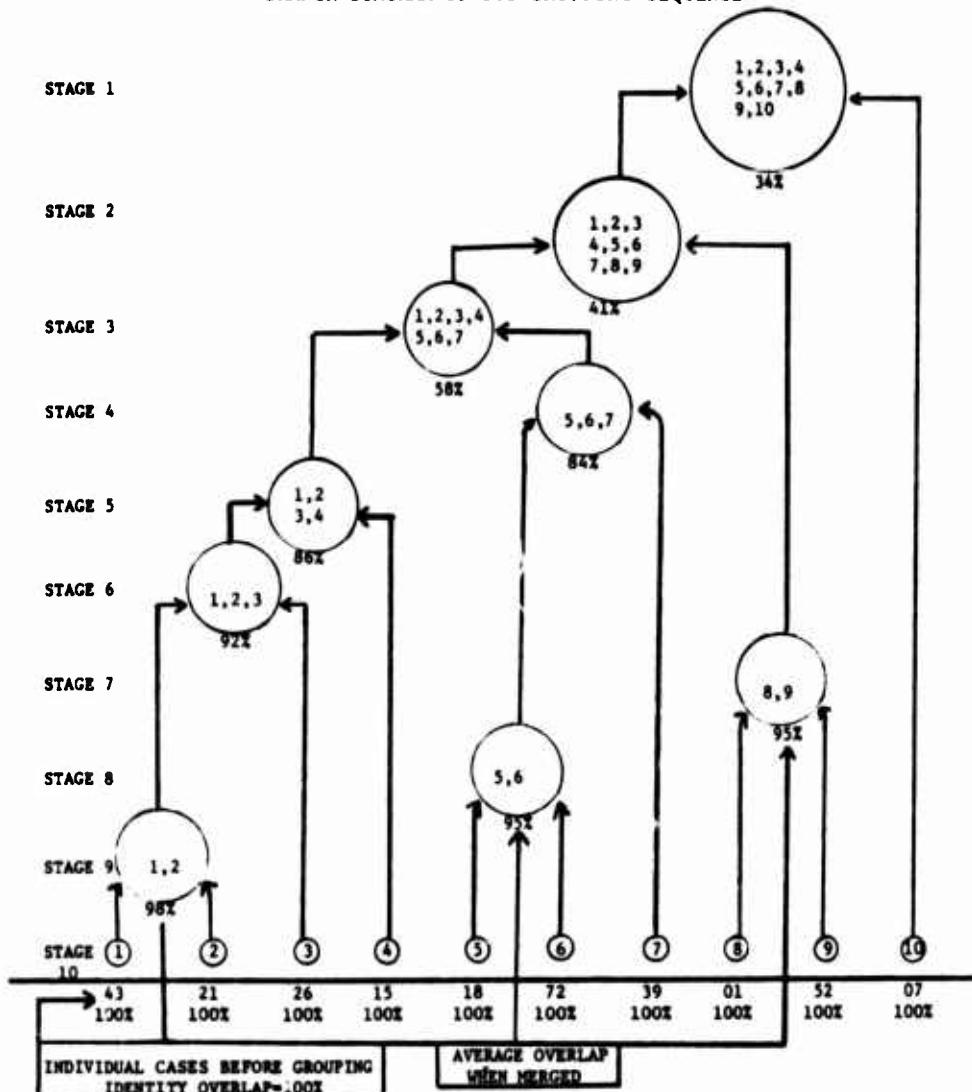
Source: Archer, Wayne B., Computation of Group Job Description from Occupational Survey Data. PRL-TR-66-12. Lackland AFB, Texas: Personnel Research Laboratory Aerospace Medical Division Air Force Systems Command, December 1966.

At Stage 10, conversely, all individuals are overlapped
at 100% since they themselves are being overlapped on
their own time spent. Each person's uniqueness produces
an identity overlap with himself.

These stages are really task clusters which can be
broken down in a variety of ways - such as by pay groups,
education, length of service. The products of CODAP ana-
lyses are numerous. Here are some examples cited by
Dr. Raymond Christal:

### Example CODAP Programs

One program produces a consolidated descrip-
tion of the work performed by any specified group
of individuals. Such a description can be produced
for workers at a particular base; or for those who
have been in their jobs less than one year; or those
who claim their talents are not being utilized; or
those who work on a particular type of equipment--
indeed, for any group of workers which can be de-
fined in terms of information in the background
section of the job inventory. A consolidated job
description indicates the percent of group members
performing each task, the average percent of work
time spent on the task by those who perform it, and
the percent of group time spent on each task. A
CODAP program prints the task statements and asso-
ciated computed values, arranged in terms of per-
cent members performed, or in terms of group time-
spent values. A consolidated description of the
work performed by individuals during their first
year or two on the job is particularly useful in
validating or designing the curricula for entry-
level vocational training.

Normally, when analyzing an occupation a series
of job descriptions for groups at various experience
levels is produced. That is, consolidated descrip-
tions are computed for individuals who have been
in the occupation for less than one year; from one
to two years; from two to four years; four to eight
years; and so on. Then the CODAP system is used
to gather this information into a table which indi-
cates the percent of individuals at each experience
level that perform each task in the inventory. In
this way, we find when tasks tend to be assigned,
and when training should be given in order to be
timely.

Another CODAP program enables managers to study the differences in work being performed by any two specified groups of individuals. For example, one might wish to know the differences in work performed by individuals at one grade level and those at another grade level; or in the work performed by individuals working on two types of equipment. The CODAP system analyzes the two defined groups and prints a report summarizing the major differences in work performed.

Perhaps the most powerful CODAP program is one which identifies and describes all the types of jobs which exist in an occupational area. Beginning with 2,000 individual job descriptions, this program will compute a 4,000,000-element input matrix reflecting the similarity of each job with every other job. Then it proceeds to group similar jobs into clusters and prints out a description of work performed by individuals in each cluster. The program is iterative and may evaluate well over a billion alternative solutions in arriving at the best definition of job types and clusters in a particular occupation. Still another CODAP program can be used to determine the characteristics and locations of individuals working in each job type and cluster. The results of job typing analyses are extremely valuable in identifying changes needed in defining occupational categories in an organization or military service.

Other CODAP programs can be used compute job descriptions for individuals, or for each individual in a specified group, or to compute the amount of work time each worker spends on a given set of tasks. Using factor ratings in conjunction with task data, CODAP can be used to compute the difficulty level or the grade requirement for each job. Programs are available within the CODAP which will produce two-way frequency distributions between background variables; compute the difficulty level of each task; compute intercorrelations among background variables; determine the reliability of task factor ratings; compute the average grade level or the average experience level of workers performing each task; compute regression equations;

print task lists, or print a dictionary of back-
ground variables. The CODAP system is also a
general occupational information retrieval sys-
tem. All reports, descriptions, and analysis
results computed by CODAP are stored and identi-
fied. Any subset of descriptions or reports can
be extracted, ordered, and printed. CODAP even
numbers the pages in an extracted report and auto-
matically prints a table of contents. In general,
there is a CODAP program available to organize
and analyze occupational data to answer any ques-
tion asked by managers of a personnel system.

Dr. Christal's remarks provide the reader with a
sampling of some very useful applications of CODAP. The
consolidated job descriptions referred to are shown in
Exhibit 7. A brief discussion of the task job descrip-
tion is in order as it serves a primary purpose for the
goals of this paper.

(Exhibit 7, about here)

Exhibit 7 lists all the tasks currently performed
in a survey of 394 journeymen medical laboratory specia-
lists. The tasks are arranged by the percent of indivi-
duals performing a given task. Thus, "collect blood
specimens directly from patients" is common to 93.40%
of all those surveyed or 368 of this job family perform
this task.

The average percent time spent by members performing
this task is 1.7%. That is, we know that "collecting blood,"
task #18, is not only the most common task to the group,
but is one of the most time consuming. That is, a quick
scan of the value 1.7% down the second column shows no
other task taking as much time.

Exhibit 7

TASK JOB DESCRIPTION FOR JOURNEYMEN MEDICAL LABORATORY SPECIALISTS (N=394)

CUMULATIVE SUM OF AVERAGE PERCENT TIME SPENT BY ALL MEMBERS
AVERAGE PERCENT TIME SPENT BY ALL MEMBERS
AVERAGE PERCENT TIME SPENT BY MEMBERS PERFORMING
PERCENT OF MEMBERS PERFORMING

| D-TSK | TASK TITLE | | | | |
|-------|-----------|------|------|------|------|
| F 18 | Collect Blood Specimens Directly from Patients | 93.40 | 1.70 | 1.58 | 1.58 |
| J 3 | Perform Blood Count | 89.09 | 1.56 | 1.39 | 2.98 |
| J 24 | Perform Hematology Procedures for Hematocrit Tests | 89.09 | 1.45 | 1.30 | 5.60 |
| J 5 | Prepare Blood Smears | 89.85 | 1.39 | 1.25 | 8.10 |
| M 9 | Perform Urinalyses for Glucose Tests | 87.82 | 1.38 | 1.21 | 10.53 |
| N 6 | Perform Urinalyses for Albumin Tests | 87.06 | 1.36 | 1.19 | 12.92 |
| J 6 | Separate Serum from Blood | 87.31 | 1.30 | 1.14 | 16.40 |
| M 4 | Operate Spectro-Photometer | 77.66 | 1.34 | 1.04 | 19.62 |
| G 1 | Examine Specimens Microscopically | 86.04 | 1.18 | 1.01 | 22.69 |
| F 12 | Prepare Solutions and Standards | 86.55 | 1.09 | 0.94 | 25.62 |
| G 11 | Stain Bacteriological Smears | 85.28 | 1.08 | 0.92 | 28.41 |
| J 1 | Identify Immature Blood Cells | 86.29 | 1.04 | 0.89 | 31.09 |
| F 14 | Prepare Specimens for Shipment | 84.26 | 1.03 | 0.87 | 33.72 |
| L 18 | Type Blood of Donors and Recipients | 74.87 | 1.10 | 0.83 | 35.38 |
| L 17 | Test Blood for RHO or DU Factors | 76.14 | 1.04 | 0.79 | 37.78 |
| M 5 | Prepare Reagents and Standards | 75.38 | 1.01 | 0.76 | 39.32 |
| I 6 | Identify Protozoans, Cestodes, Nematodes, or Trematodes | 74.62 | 0.95 | 0.71 | 42.26 |
| N 8 | Perform Urinalyses for Bile Tests | 85.28 | 0.80 | 0.62 | 44.34 |
| N 3 | Perform Kidney Function Tests | 76.14 | 0.89 | 0.68 | 47.05 |
| M 17 | Perform Biochemical Procedures for Chlorides Tests | 71.07 | 0.89 | 0.63 | 50.95 |

Exhibit 7, Cont'd.

| D-TSK | TASK TITLE | CUMULATIVE SUM OF AVERAGE PERCENT TIME SPENT BY ALL MEMBERS | AVERAGE PERCENT TIME SPENT BY ALL MEMBERS | AVERAGE PERCENT TIME SPENT BY MEMBERS PERFORMING | PERCENT OF MEMBERS PERFORMING |
|---|---|---|---|---|---|
| M 38 | Utilise Methods for Electrolyte Determinations | 61.68 | 1.00 | 0.61 | 53.43 |
| E 7 | Maintain Files of Laboratory Records or Reports | 51.27 | 1.14 | 0.59 | 55.20 |
| J 18 | Perform Hematology Procedures for Eosinophile Count | 80.46 | 0.71 | 0.57 | 57.51 |
| J 29 | Perform Hematology Procedures for Sickle Cell Preps | 82.74 | 0.68 | 0.56 | 59.21 |
| F 20 | Collect Pus Specimens Directly from Patients | 65.99 | 0.80 | 0.53 | 61.37 |
| H 4 | Perform KOH Preparation for Dermatophyte | 68.02 | 0.72 | 0.49 | 63.35 |
| I 6 | Maintain Donor Files | 58.63 | 0.79 | 0.47 | 65.74 |
| A 5 | Assure the Availability of Equipment and Supplies | 42.64 | 1.06 | 0.45 | 67.57 |
| M 42 | Utilise Methods for Titrimetric Procedure | 55.33 | 0.80 | 0.44 | 69.79 |
| H 1 | Cultivate Mycology Specimens for Primary Isolation | 56.09 | 0.77 | 0.43 | 71.10 |
| N 4 | Perform Pregnancy Tests | 48.48 | 0.84 | 0.41 | 73.57 |
| L 7 | Maintain Files of Blood Banking Forms | 53.30 | 0.74 | 0.39 | 75.16 |
| L 14 | Screen and Schedule Donors | 50.51 | 0.72 | 0.36 | 77.04 |
| A 21 | Plan Reports for the Section | 32.99 | 0.99 | 0.33 | 79.45 |
| H 6 | Stain Mycology Specimens | 48.22 | 0.62 | 0.30 | 81.34 |
| A 14 | Establish Procedures for Special Tests | 36.29 | 0.74 | 0.27 | 83.36 |
| F 15 | Prepare Specimens for Training or Reference | 36.29 | 0.67 | 0.24 | 85.42 |
| D 8 | Indoctrinate Newly Assigned Personnel | 35.28 | 0.67 | 0.23 | 87.09 |
| M 29 | Perform Biochemical Procedures for Salibylate Level | 32.49 | 0.61 | 0.20 | 89.46 |

The third column of Exhibit 7 shows the average per-
cent time spent by all members.  This includes all 394
of the total numbered survey.  The average time for all
members of the group surveyed is less than time spent
by members performing in this case since not everyone
performed this task.  However, when we look at column
four we see that the cumulative sum of average time
spent by all members starts with this figure (1.58%).
Then, we see that this fourth column keeps summing aver-
age time by all members on tasks until we could reach
100%.

For the job analyst a determination can be made
as to the percent of tasks necessary to perform ade-
quately in a job (such as 60%).  The remaining tasks
may be incidental or perhaps learned on the job.  The
remaining tasks are of lesser importance for qualifi-
cation standards or for job evaluation.

Exhibit 7 displays the frequency of task perfor-
mance for a field of work in a way not currently known
to many occupational analysts.  Frequency often is re-
ported by expert judgment.  Frequency reported by other
survey techniques divides the total sample group into
each task to produce a percentage figure.  This is then
taken as the frequency of task statistic.  For example:

| Task | No. Responding | ÷ | Total Surveyed (394) | = | % Performing |
|------|----------------|---|----------------------|---|--------------|
| 1    | 30             |   | "                    |   | 8            |
| 2    | 150            |   | "                    |   | 38           |
| 3    | 250            |   | "                    |   | 63           |
| Kth  | 368            |   | "                    |   | 93           |

Now, for any given task the percent who perform the task does not reveal how much time they spend performing the task. For example, CODAP will show average percent time spent. More importantly, if the range of members performing is 1% average time to 100% of average time spent on that task (column two of Exhibit 7) then the frequency measure tells us very little. All we know is that many people perform the task. Interpretation of frequency is impaired without having average percent time and being unable to inspect the range of time spent. Both of these statistics are reported by CODAP.

Another important yield of CODAP mentioned by Christal is exemplified by Exhibit 8.

(Exhibit 8, about here)

This Exhibit shows the difference between two samples of workers in the same job family. One group are apprentice laboratory technicians while the other are journeymen. The first column shows percent time spent on task by the apprentices. Column two shows the percent time spent on task by the journeymen. Column three subtracts the time spent on task from the more experienced group. The difference indicates what the apprentices don't currently do, or how little of their time is spent on the task compared to the experienced population. One implication for career counseling, training, and ultimately qualification standards is to

Exhibit 8

## SAMPLE DIFFERENCE DESCRIPTION

GROUP 1 = APPRENTICE DENTAL LABORATORY TECHNICIANS (N=30)
GROUP 2 = JOURNEYMAN DENTAL LABORATORY TECHNICIANS (N=272)

| | | DIFFERENCE IN PERCENT PERFORMING GROUP 1 MINUS GROUP 2 | | |
| | | PERCENT PERFORMING, GROUP 1 | | |
| | | PERCENT PERFORMING, GROUP 2 | | |

| D-TSK | TASK TITLE | | | |
|-------|------------|-------|-------|--------|
| K 14 | Perform Dental Assistant Functions | 12.87 | 33.33 | 20.47 |
| M 6 | Maintain Boilout Tanks | 52.57 | 70.00 | 14.43 |
| M 7 | Maintain Dehydrating Equipment Ovens | 11.40 | 26.67 | 15.27 |
| M 26 | Trim Casts | 55.51 | 70.00 | 14.49 |
| N 11 | Eliminate Wax from Denture Molds | 56.99 | 70.00 | 13.01 |
| J 21 | Soak Master Casts | 29.78 | 40.00 | 10.22 |

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

TASKS OMITTED WHERE DIFFERENCES IN PERCENT PERFORMING = 10.00 THROUGH -20.00

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

| K 17 | Solder Units of Fixed Partial Dentures | 33.46 | 13.33 | -20.12 |
| K 9 | Fabricate Stone Dies | 40.81 | 20.00 | -20.81 |
| K 1 | Cast Gold Crown, Inlay, or Pontic Backing | 38.24 | 16.67 | -21.57 |
| B 13 | Supervise the Fabrication of Dental Prosthetic Appliances | 22.06 | 0.00 | -22.06 |
| K 13 | Grind in Porcelain or Acrylic Facings and Pontics | 39.71 | 16.67 | -23.04 |
| K 5 | Fabricate Acrylic Resin Jacket Crowns | 32.72 | 6.67 | -26.05 |

<u>focus on the positive values at the top of Exhibit 8</u>.
Presumably, apprentices require experience (via occu-
pational restructuring) or training on those tasks
where the difference is great <u>and</u> the journeymen are
performing the task.  A similar example can be made
for job evaluation contrasting two different groups
of skill wherein the analyst wishes to construct an
equitable pay scale.

Summing up CODAP's utility, one can readily
see that the TI, when matched with the power of com-
puter assistance, produces highly usable information
for occupational analysis.  CODAP, as a package, pro-
duces reports in form that the user can quickly in-
terpret.  As Exhibit 3 on comparative attributes of
occupational analysis argues, measurement, generaliza-
bility, low cost, speed and capacity, and exhaustive-
ness are deftly exploited t·· CODAP.  Therefore, the
pay-off to qualification standards development, train-
ing program development, occupational restructuring,
and job evaluation is quite high.

## JOB PRICING AND EVALUATION

A special application of the TI/CODAP is job pric-
ing and evaluation.  This section reviews the common
methods and indicates how the TI/CODAP offers a step
forward in this area.

### Factor Comparison Method

Only 10% of compensation systems probably use this
system of job evaluation.  One notable example of this
system is the Hay System.  One so-called advantage of
this system is that it is "custom built" for each or-
ganization.  We consider this a disadvantage since com-
parability across organizations facilitates wage and
salary surveys.  Thus, job comparison scales within or-
ganizations are less sensitive to true labor market
conditions.  Another disadvantage of the Factor Compari-
son Method is that "universal" factors simply do not
exist in all jobs and all organizations.  Also, key jobs
become critical as bench marks, but jobs change all the
time.  Thus, some key jobs in the scale no longer repre-
sent the bench marks they once did.  The usefulness of
the scale suffers.  As one expert argues, it becomes a
warped ruler.  (Belcher, 1975).

## The Point Method

Some say this is the most common and easily adapted system. Jobs are broken down in compensable factors. A numerical score on these factors produces a value of the job. Rating scales are constructed for compensable factors. A definition of this factor and degrees of this factor are outlined for each rater. Points are allocated for each degree.

Major disadvantages of this well-known system are:

1) difficult to develop

2) meanings of each factor and its degrees can be difficult to establish

3) great clerical detail is required to keep this system's "logic" intact

4) occupational analysis is definitely required and no one uniform system is employed - thus comparisons of compensable factors is always difficult

## TI/CODAP Method

A newer technique is the task inventory combined with CODAP. Point Method Plans have existed with the job checklist (Bellows & Estep, 1948; Ferguson, 1948). Thus, the TI/CODAP, which is an extension of the checklist, can put clear job information into the Point Method to simplify this system. Therefore, major disadvantages are minimized because an empirically based job analysis system produces easily rated points.

Here is a list of the most commonly used job evalua-
tion points for which the TI/CODAP can produce meaningful
information:

Education at the task level

Experience at the task level

Training at the task level

Complexity of tasks by who performs task

Responsibility for:

function

procedures

data

errors

money

Contacts  at the task level

Working conditions at the task level

Hazards at the task level

Supervision

In sum, the normal points are associated   in a clear,
meaningful form with clustering actual time spent on
tasks.     Qualitative weights for these task clusters
can be arrayed to produce scores for proficiency at the
task level, task difficulty, and level of responsibility.
In this way TI/CODAP simplifies the judgments necessary
for job evaluation by describing the work content at the
task level in its clearest form.

Managerial discretion will not be obviated by the TI/CODAP, but the basis for job pricing will be an information system that is data based, efficient, updatable, computer reported, and more objective than contemporary systems of job evaluation.

## Validity and Reliability

The TI has undergone extensive testing for validity and reliability. Validity, of course, is the correspondence between reporting task data and actual performance on the job. Some validity studies have already been reported on in this report (e.g., Carroll and Taylor, 1969; Stodgill and Shortle, 1955; Morsh, et al, 1968). Moore, et al, 1974, validated task data of subordinates with independent supervisory ratings. Across seven job families (N's of 18 to 76), agreement ranged from 63 to 88%. This is surprisingly high since supervisors must be aware of both the work process and the worker.

No one validation study answers the question of validity for any particular survey. Therefore, the TI/CODAP has techniques built into it. Inspection of the data reveals if a large proportion answers task statements the same way. This is a form of validation because consistent error is unlikely. Other techniques can include task statements that are always or never done. Isolating "false" responses into those two categories permits breaking down the pattern of responses. Curiously, re-

search has shown that responders who say they do more tasks than responders who indicate fewer tasks tend to be more accurate (Ammerman, 1960).

The point to consider about validation is that each survey should incorporate a validation assessment. Veracity items can be included in the TI. Sub-samples, on occasion, can be drawn and a check on the correspondence between reporting task data and actual performance can be made.

Reliability is easier to assess. Test-retest correlations range from the mid .70's to the high .90's (c.f. Ammerman, 1960; McCormick and McCormick, 1960; Tombrink, 1960; Christal, 1974; Moore, et al, 1974). Perhaps the best reliability study is that of McCormick, 1960:

> Fifty-six airmen were asked to report various combinations of the following information: whether or not they performed each task, the frequency of task performance, the time required for performance of each task, and the judged mental difficulty of each task. Analysis of variance showed no systematic differences in the number of tasks reported by incumbents who were asked to report one, two, three, or all four types of information about tasks. Incumbents who were required to report more (as opposed to fewer) types of information about their tasks tended to provide more reliable information. Among the different sub-samples of incumbents there was considerable stability in the number who reported that they performed a particular task. It appears that if incumbents must read each task statement closely in order to follow instructions they will give reliable information, but if they are just required to check the statements they may not read them carefully.

3)     to develop an instrument for use in the pre-
paration of interprovincial standards exami-
nation (Red Seal), and in the preparation of
curricula for instruction leading to the
journeyman qualification;

4)     to facilitate the mobility of a journeyman
in Canada by the award of the Red Seal on a
journey certificate, recognized by all pro-
vinces and territories for purposes of jour-
neyman certification;

5)     to supply employers, unions, training insti-
tutions and members of the labor force with
a list of trade tasks which they can readily
assess.

Point 1 above calls for the proper identification
of the task. From Exhibit 3 onward, it is argued that
the measurement properties of the TI are excellent.
Since the job incumbent is the best source of occupa-
tional information, the survey technique of the TI per-
mits task identification to be collected where it occurs -
in the world of work.

Point 2 above asks that tasks stated in the occupa-
tional analysis be applicable to journeymen in every
province. Current methods ask provincial experts to
produce this judgment. The TI/CODAP provides a data
base which clearly indicates the variation of task by
region and gives the frequency of task performance.
Since this TI is a survey technique, this information
base can be updated yearly or whenever shifting labor
markets demand it. Often, "experts" are surprised by
the true distribution of tasks which describe a trade.

Again, each study of the past on the TI merely gives us more confidence about validity and reliability. Each application of the TI should carefully analyze the responses for truthfulness and consistency. Small sub-samples can be drawn. Test-retest coefficients can be computed. In this way, generalization and decision making are enhanced.

## Relevance

., is section discusses the relevance of the TI/ CODAP for manpower analysis, career ladder development, and manpower modelling. Specifically, each of the objectives will be the focus of discussion as to how the TI/CODAP offers better information than current techniques.

## Canadian Occupational Analysis

An occupational analysis, as developed by the Canadian federal government under the guidance of the Interprovincial Standards Program Coordinating Committee, has the following objectives:

1)     to identify the tasks performed by a journey-man in a particular trade;

2)     to obtain interprovincial acknowledgement that the tasks stated in the trade analysis are applicable to journeymen in every province;

Point 3's objective is to develop an examination
instrument for the Red Seal program. Task based exams
do exist in the form of performance examinations. How-
ever, validation of the examination as an examination
must be performed. That is, item analysis must be under-
taken to assess if the test instrument discriminates
properly. There is no reason, per se, why task based
performance tests can't be better than achievement/apti-
tude tests. The methodology is straightforward. Also,
validation of a task-based test offers additional sources
of validation since exam results can be vouchered. That
is, the results of the exam are in a form that previous
employers, supervisors, etc., can recognize. If their
cooperation is secured, they can voucher the examinee's
test performance against their knowledge of his work
performance.

The second part of Point 3 asks that preparation
of curricula for instruction be developed. The TI/CODAP
was invented for that purpose. Task-based data that are
current and accurate provide enabling and terminal ob-
jectives for curricula developers. The systems approach
to training is based on occupational analysis that pro-
duces sufficient description of an occupation so that
training will be optimal. That is, under and over train-
ing are to be avoided. Curricula developers need to
know how much and to what standard tasks are performed.

Then, they as experts can provide the knowledge and technique suitable to perform in those tasks. Thus, the occupational analysis serves as a basis for curriculum content <u>and</u> a specification of goals (the terminal objectives). Many experts have cited the problems of merely letting curriculum experts build training programs in a vacuum. Some advise to keep curricula developers isolated from the occupational analysis.

Point 4 seeks to facilitate the mobility of journeymen via the Red Seal program. Given the speed at which the TI/CODAP reports out relevant occupational data, occupational analysis can be performed in months rather than years. Since certification is best made with empirical evidence rather than expert judgment alone, it seems that the TI/CODAP has much to offer Point 4.

Lastly, Point 5 seeks to supply to the labor exchange mechanism a list of tasks which are in a form that permits quick comparison of man/job matching. The TI/CODAP can print consolidated or specialized task lists in many different ways. These reports can be for entire job family surveys, as in Exhibit 7, or specialized groups, as in Exhibit 8. The lists of tasks can be for individuals, organizations, or regions. Very simple commands to CODAP produces very elaborate, yet digestible, reports.

Summing up the objectives of the Canadian Occupational Analysis, the TI/CODAP offers one incremental step over current procedures. For example, current techniques list the task at a level that is either too general or too comprehensive, i.e., it is more than one task. For instance, in the Canadian Carpentry Trades analysis task 1.1:

> Examine excavations to determine the sufficiency of the bearing strata to the extent that any unsatisfactory conditions are reported to the builder re: unequal bearing strength over the area of proposed building and any unsafe conditions re possible bank collapse.

Each type of excavation examination for sufficiency mentioned above may very well be at the level of measurement for the task statement. Therefore, task 1.1 may be broken into 5 or 6 tasks, but the response pattern may vary by region, industry, etc. Ultimately, TI/CODAP will tell us whether a simple statement of "Examine excavations" is all that is necessary or whether six task statements are better. In other words, the answer is derived from the data. The point here is that the current language of the task is disguising discrete tasks, or, at times, could be specifying duties rather than behavioral tasks. The significance is that if duties or multi-task embedded statements are used, respondents cannot honestly provide data. If a journeyman only performs one type of examination of excavations, should he answer the entire

statement or not answer it at all? Of course, if the occupational analyst is answering this statement by virtue of FJA methodology, then this paper argues that good measurement has already been lost (see Exhibit 3).

Task 1.1 also deals with frequency which is of crucial importance to the objectives of the Canadian Occupational Analysis. Currently, methodology asks for expert opinion on frequency. TI/CODAP reports it out as actual. Research experience has amply demonstrated that there are real gains in capturing frequency of task by survey methods. Unlike weaker survey methodologies, however, CODAP reveals the relative time spent on task. This is much more sensitive as a frequency measure and permits comparisons of differences to be computed (see Exhibit 8). The distinction is not a small one. For example, Task 1 could be revealed as equally frequent for both apprentices and journeymen. With CODAP, however, the following figure shows why the science of occupational analysis has been advanced:

Exhibit 9

TASK 1 - OVERLAP
"Examine Excavations"

Time Spent
by Apprentice _____
9%

Time Spent by
Journeymen
25%

Overlap of apprentice with
Journeymen

9%
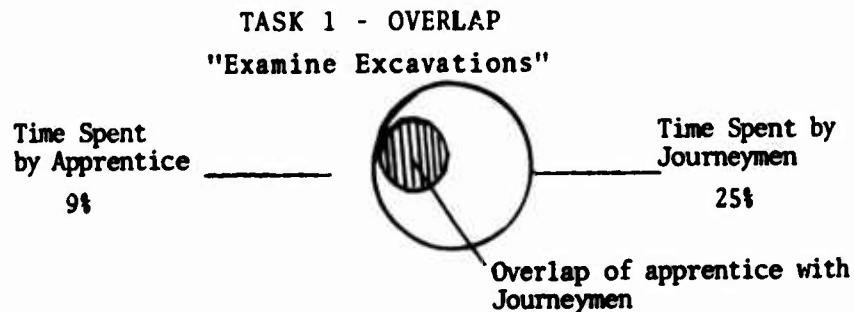
The last facet of the Canadian Occupational Analysis is the quality factor. With TI/CODAP, many different qualitative measurements can be used. For example, task difficulty has had some merit (c.f. Mead, 1970a; 1970b; Mead & Christal, 1970). It is defined as the amount of time it takes for individuals to learn to perform a task adequately. Research has shown that supervisors, experts working in the field, can agree on relative difficulty of tasks within an occupation. This variable can be clustered by CODAP the same way that relative time spent is. Many of the quality factors in the current Canadian system are really the performance of task to a standard. As mentioned earlier, the standard belongs in the task statement. However, task difficulty has many uses as a way to weight emphasis for curriculum building. Because CODAP is such a flexible software package, variables such as task difficulty can be added to other variables to create hybrid variables for occupational analysis. For example, the cross products of task difficulty and time spent can be summed across all tasks for an entire inventory. Career ladders can be computed with this statistic. These ladders indicate the range of task complexity and difficulty that make up a job family. Both vocational counseling and mobility assessment can be facilitated with this type of analysis.

## Career Ladder Development

As discussed by Christal (1974):

...most career ladders contain several types of
jobs which may vary in difficulty. The CODAP
analysis system can be used to identify these
job types, and difficulty indexes can be used
to determine which job types might be shredded
out into new management units for performance
by lower aptitude personnel. The task difficulty
indexes can also be used to identify tasks which
might be pulled out of existing jobs and engineered
into new jobs for performance by less talented in-
dividuals. However, in order to build the most
meaningful contingency plans, what is needed is a
method for comparing aptitude requirement levels
for jobs across all career ladders.

This approach can be outlined in general terms.

Step 1. Select a set of career ladders requiring the same type
of aptitudes, for which job inventories and recent
occupational survey data are available.

Step 2. Collect ratings from supervisors to determine the
relative difficulty levels of all tasks within each
ladder.

Step 3. Select 30 to 40 tasks at various difficulty levels from
each ladder. This will form the benchmark set. Relia-
bility of final results will be enhanced if the tasks
selected for the benchmark set are well known or easily
observed.

Step 4. Obtain relative aptitude requirement ratings for tasks
in the benchmark set from knowledgeable behavioral
scientists.

Step 5. Within each ladder, compute least squares regression
equations to predict task aptitude requirements from
task difficulty levels.

Step 6. Apply the equations developed in Step 5 to re-scale
all tasks in all ladders into a common aptitude require-
ments framework (the benchmark scale).

(Exhibit 9) presents 20 points representing 20 tasks on a particular career ladder which were included in the benchmark set. The position of a task on the vertical axis represents its difficulty level relative to all other tasks in its own career ladder. Its position on the horizontal axis represents its aptitude requirement level relative to other tasks in the benchmark set of tasks. A line of best fit has been drawn through the points. Using this graph, the relative difficulty index values can be converted into aptitude requirement levels for all tasks in the career ladder. If this procedure is repeated for all ladders having tasks represented in the benchmark set, the final product is a set of values indicating the relative aptitude requirement levels for all tasks in all ladders.

(Exhibit 10, about here)

## Manpower Modelling in the U.S. Navy

The challenge to the Naval manpower planner is accurately to staff the technical needs of positions and to efficiently manage the human resources available to meet those needs. To accomplish this, managers have always been faced with a need for the best assignment of people to jobs. This function, of matching people to jobs so that the resulting organization makes optimal use of the personnel available, is addressed by the multi-

Exhibit 10
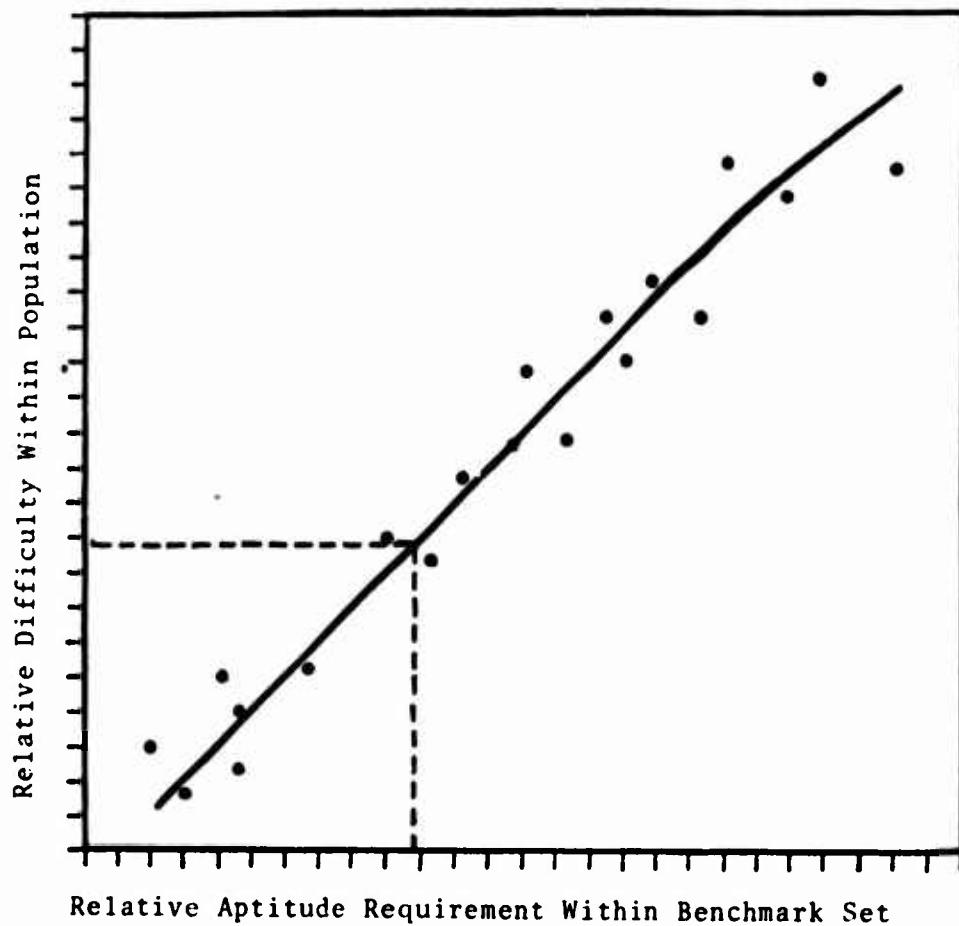


Resource:   Christal, R. E., op cit., p. 29

attribute assignment model developed by the
Office of Civilian Manpower Management (OCMM) in con-
junction with the University of Texas at Austin. Long-range
research plans are to construct a dynamic model,
which would be able to take into account the effect
of training and experience gained in each assignment.
The implementation of such a model, however, is a com-
plex undertaking, and so the first step began by working
on a static model called MODS for Models for Organizational
Design and Staffing (Charnes, Cooper, Niehaus & Stedry,
1968).

## Overview of Model

Exhibit 11 shows, in a general way, that the two
principal types of input--the descriptions of the per-
sonnel and the requirements of the jobs--are derived
from the TI. The personnel information is ready to be
fed directly into the assignment model, but the job in-
formation must first be analyzed to produce a minimum
acceptable level for each task comprised in each posi-
tion, as well as the desired, or goal, level. It is
also possible to specify weights to indicate that some
goals are more important than others.

(Exhibit 11, about here)

For the central computer program, a preliminary
pass eliminates any man-job combinations in which a

Exhibit 11

Models for Organizational Design and Staffing - MODS
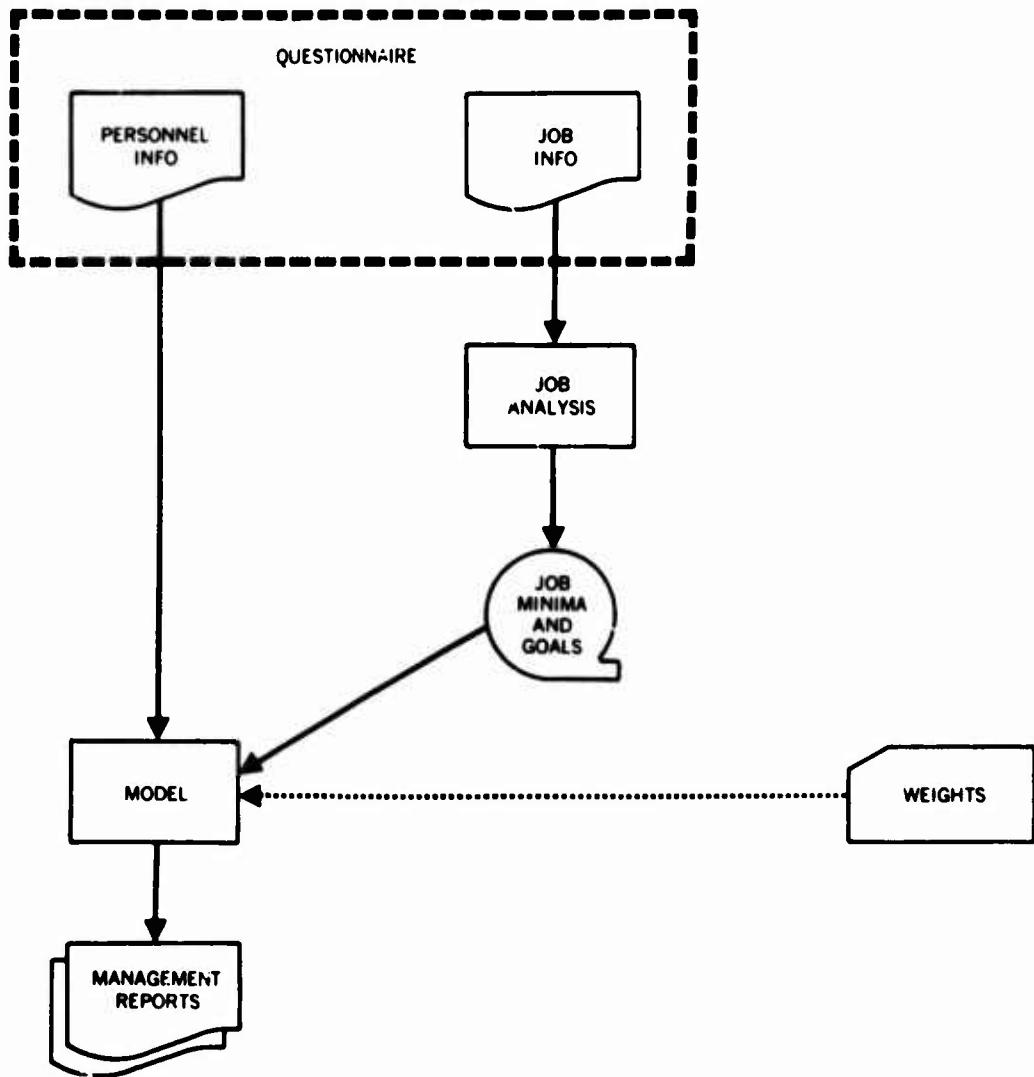


Source: Moore, B.E., et al, "Using Task Surveys in Assigning
People," The Journal of Navy Civilian Manpower Management,
No. 4, Winter, 1974

given person cannot meet the minimum requirements for that job. The computerized model then looks simultaneously at all of the remaining personnel described and jobs to be filled, and finds that set of assignments which will result in all of the goals being met as nearly as possible. The distribution routine which actually finds the optimum match was provided by Dr. D. Klingman of the University of Texas at Austin (1972).

The management reports produced are four: a listing of the optimal assignments, a listing by person of all jobs for whic. he is minimally qualified, a register by job of all persons minimally qualified, and a training requirements report which lists .ne tasks and the degree of deviation from the standard required by management.

Exhibit 12 is a section of an actual task inventory. Step 1 merely asks the respondent to check whether he does the task or not. The purpose is to review the entire list before making any ratings; at this juncture, job incumbents are recognizing and recalling the tasks they perform. Additions to the list may occur at this time.

(Exhibit 12, about here)

Step 2 in Exhibit 12 asks for the now familiar relative time spent on each task performed. Once we have relative time ratings for tasks performed, the ratings can be converted into estimated percentage of

## Exhibit 12

**MACHINE TOOL FAMILY**

**3400**

**Each step should be performed for the full list of tasks
before proceeding to next numbered step**

---

**STEP 1.**

DESCRIBE YOUR PRESENT JOB BY
CHECKING ( ) ONLY THOSE TASKS
IN YOUR PRESENT JOB

---

**STEP 3.**

ENTER YOUR QUALIFICATION FOR ALL
TASKS IN MACHINE TOOL FAMILY. USE
LETTER CODE A-E. AND N AS BELOW.

A. LIMITED EXPERIENCE, NEED
   INITIAL TRAINING OR ASSISTANCE.
B. SOME KNOWLEDGE AND EXPERIENCE
   NEED OCCASIONAL ASSISTANCE.
C. CAN PERFORM ALL NORMAL WORK IN
   THIS TASK.
D. BROAD EXPERIENCE. CAN ASSIST
   OTHERS.
E. ABLE TO INSTRUCT AND DO
   DIFFICULT WORK.
N. NOT IN MY FIELD.

---

**STEP 2.**

INDICATE RELATIVE TIME ON EACH TASK
IN PRESENT JOB. ONLY ENTER TIME
FOR TASKS YOU CHECKED ON STEP 1
USE NUMBER CODE 1-7 AS BELOW. (TIME
DOES NOT NECESSARILY = IMPORTANCE)

1. VERY MUCH BELOW AVERAGE TIME
   ON THIS TASK.
2. BELOW AVERAGE TIME.
3. SLIGHTLY BELOW AVERAGE TIME
4. AVERAGE TIME.
5. SLIGHTLY ABOVE AVERAGE TIME
6. ABOVE AVERAGE TIME.
7. VERY MUCH ABOVE AVERAGE TIME
   ON THIS TASK.

---

| STEP 1. CHECK OWN JOB TASKS | STEP 2. ENTER TIME CODE |
|---|---|

**STEP 3.**

ENTER OWN
QUALIFICATION
FOR EACH TASK

---

**DUTY A- READING BLUEPRINTS, MECHANICAL DRAWINGS, AND SKETCHES**

| Qual | # | Task | Check | Time |
|---|---|---|---|---|
| E | 1. | READ SKETCHES AND SINGLE VIEW BLUEPRINTS. | ✓ | 6 |
| E | 2. | INTERPRET SIMPLE TWO OR THREE VIEW SKETCHES. | ✓ | 7 |
| D | 3. | INTERPRET ASSEMBLY DRAWINGS AND LAYOUT DETAILS WHEN NO DETAIL DRAWINGS ARE AVAILABLE. | ✓ | 5 |
| D | 4. | READ AND INTERPRET COMPLEX DRAWINGS FOR THREE VIEWS WITH CUTAWAY SECTIONS. | ✓ | 3 |
| C | 5. | READ DESIGN SYMBOLS AND SPECIFICATIONS REQUIRED TO LAY OUT SKETCH TYPE DRAWINGS, USING THREE VIEWS—TOP, FRONT, AND SIDE. | ✓ | 2 |
| C | 6. | IDENTIFY SHAPES, TOLERANCES, DIMENSIONS, FINISHES, AND TOOLING POINTS FROM COMPLEX BLUEPRINTS AND MECHANICAL DRAWINGS. | | |

ADDITIONAL TASKS:
ADD ANY SIGNIFICANT TASKS IN YOUR PRESENT JOB WHICH ARE
NOT LISTED.

time values. These data can then be analyzed by CODAP
to find the degree of overlap of two or more jobs. The
identification of similar task clusters leads to the
definition of job-types--a form of job description.
These job-types are behavioral job descriptions, which
is to say that they do not represent what people ought
to be doing, but rather just what they actually report
themselves to be doing.

In Step 3 of Exhibit 12, the job incumbent indicates
his proficiency in a given task, ranging from A (limited)
to E (expert). In agreement with Campbell, Dunnette,
and Arvey (1973), personnel assessment ought to focus on
meaningful samples of work behavior rather than signs
or indicators. The better predictors of proficiency
(potential or actual) should be samples of the work be-
havior in terms reflecting the context of work, i.e.,
the task. Also, in the new era of equal employment
opportunity (EEO), all organizations must be able to
prove that personnel measures are related to satisfac-
tory levels of productive human performance. This is
equally true for promotion as well as entry level screen-
ing procedures. What the MODS is investigating as a
meaningful sample of work behavior is reflected in
Exhibit 12. The effectiveness of job proficiency measures
is highly dependent on the accuracy and completeness of
job information. Therefore, personnel proficiency is to

be measured as it is related to a specific task statement of job behavior. Since a current job may not call for all the proficiencies the incumbent has, it is quite possible a larger number of proficiencies will be scored. Retention of this information for a skills inventory is one of the by-products the assignment model offers. Notice that task 6 of Exhibit 11 is marked for proficiency, but not the job. The job doesn't currently call for this task, but the information is stored in the skills bank of MODS.

As a first test of validity of the TI, supervisors were presented with clusters of relative time spent in certain tasks and were asked to identify the men associated with these clusters. This they found easy to do within their departments.

Later, convergent validation was assessed statistically. Each supervisor vouchered all subordinates' ratings of task performance for the MODS independently. Subordinates' ratings (close to 200 tasks) were subtracted from the supervisors' independent ratings of each subordinate. Clearly, perfect agreement equals zero; e.g., low subordinate rating of 2 minus low supervisor's rating of 2 equals zero. Our data analysis for one job family shows 63% agreement (N=79). Item analysis shows that four task statements caused widespread disagreement.

By eliminating these ambiguous items, the increase in the percentage of agreement rose to 88%. In general, research shows that the smaller the unit of description the more stable descriptions tend to be. These ratings are based on discrete tasks which ranged to almost 200 significant tasks.

## Assigning People to Jobs

The TI was employed by the U.S. Navy to describe people in terms of personnel proficiency. Occupational analysis by CODAP was combined with supervisory specification of minimum and ideal levels of job performance on tasks. Exhibit 11 indicates how these data were collected via the TI then merged by the MODS for person/job matching.

The MODS now looks simultaneously at all of the personnel described and all jobs to be filled. Assignments will result in all the goals of the tasks being met as nearly as possible. Exhibit 13 displays the fictionalized names of the optimal assignments for each position, i.e., those who deviated least from ideal levels of task performance. Two other reports of possible matches are also shown. These indicate people by jobs or jobs by people. That is, these are the rosters of those who meet minimal levels of task performance required in a job, but not the ideal. The implications for the manpower planner

are many. For example, as job requirements change, new goals can be set by personnelists on expanding or changing positions.

(Exhibit 13, about here)

The optimal assignments in Exhibit 13 reflect a management report that is not of use in the case of a single civilian position being filled. However, the register of the minimally qualified shown in Exhibit 13 could be useful to the selection committee for single position assignments. But there are many applications in the Navy in which it is necessary to assign numbers of people at the same time. One such case is that in which a number of graduates from an apprentice program need to be placed. Another case is that of large activities which hire a number of people with similar backgrounds at the same time - for instance, at the end of a school year. Or again, across-command management intern programs might find the MODS useful.

The fourth and final management report of the MODS is the training requirements report. This displays individuals by position and lists their proficiency on that task against the goal or standard required for ideal performance. This report becomes a training plan for one individual or the same report can be aggregated to produce a group training requirements report. Other possible uses have been specified as in the Upward Mobi-

## Exhibit 13
## MODS Management Reports

### OPTIMAL ASSIGNMENTS

| JOB NUM | JOB DESCRIPTION | SSN | PERSONNEL NAME |
|---------|----------------|-----|----------------|
| 380091001 | SHEET METAL MECHANIC | 666666666 | SESTUS PROMMEN |
| 380611001 | SHEET METAL MECHANIC | 333333333 | THEO SINGER |
| 380611002 | SHEET METAL MECHANIC | 111111111 | ONEDA NORTH |
| 380611003 | SHEET METAL MECHANIC | 222222222 | TOBY LOVE |
| 380690001 | SHEET METAL MECHANIC | 150000000 | QUINCY MALL |
| 380691001 | WELDING BACKGROUND | 130000000 | THERESA WEST |
| 388013001 | MODEL MAKER-WELDING-SHT-PL | 170000000 | MILLIE GRAHAM |
| 388093001 | WELDING BACKGROUND | 444444444 | FREDERICK PIERCE |
| 388093002 | WELDING BACKGROUND | 180000000 | CLEE NAIR |
| 388093003 | WELDING BACKGROUND | 110000000 | ELIZAH BETH |
| 388093004 | WELDING BACKGROUND | 555555555 | PENROD STOPPER |
| 388193001 | MODEL MAKER SH AND PL METAL | 999999999 | NINA KNELL |

### POSSIBLE MATCHES BY PERSON

| SSN | PERSONNEL NAME | JOB NUM | JOB DESCRIPTION |
|-----|----------------|---------|-----------------|
| 100000000 | DECIUS YELLEN | | |
| | | 388091000 | WELDING BACKGROUND |
| 110000000 | ELIZAH BETH | | |
| | | 380611000 | SHEETMETAL MECHANIC |
| | | 380091000 | WELDING BACKGROUND |
| | | 388093000 | WELDING BACKGROUND |
| 111111111 | ONEDA NORTH | | |
| | | 380611000 | SHEETMETAL MECHANIC |
| | | 380091000 | WELDING BACKGROUND |
| 120000000 | TWYLA KING | | |
| | | 380611000 | SHEETMETAL MECHANIC |
| 130000000 | THERESA WEST | | |
| | | 380611000 | SHEETMETAL MECHANIC |
| | | 380091000 | WELDING BACKGROUND |
| | | 388093000 | WELDING BACKGROUND |

### POSSIBLE MATCHES BY JOB

| JOB NUM | JOB DESCRIPTION | SSN | PERSONNEL NAME |
|---------|----------------|-----|----------------|
| 380690000 | SHEET METAL MECHANIC | | |
| | | 150000000 | QUINCY MALL |
| | | 170000000 | MILLIE GRAHAM |
| | | 180000000 | CLEE NAIR |
| | | 333333333 | THEO SINGER |
| | | 666666666 | SESTUS PROMMEN |
| | | 999999999 | NINA KNELL |
| 380691000 | WELDING BACKGROUND | | |
| | | 100000000 | DECIUS YELLEN |
| | | 110000000 | ELIZAH BETH |
| | | 111111111 | ONEDA NORTH |
| | | 130000000 | THERESA WEST |
| | | 140000000 | CORY BOTTOM |
| | | 150000000 | QUINCY MALL |
| | | 170000000 | MILLIE GRAHAM |
| | | 180000000 | CLEE NAIR |
| | | 333333333 | THEO SINGER |
| | | 444444444 | FREDERICK PIERCE |

lity Program where the model could be used to help in determining which people ought to be directed to what jobs. Related to this use would be that of establishing training requirements for personnel by indicating the discrepancy between current capabilities of incumbents and position requirements. Still another area is that of evaluating combinations of military-civilian assignments.

Eventually, of course, the MODS hopes to deal with multiple periods. Such a dynamic multi-attribute assignment model would be needed to address the problems of organizational redesigning, and ultimately could be used in conjunction with other OCMM manpower planning models.

## Summary and Conclusions

This paper reviews the history and development of the task inventory within the general context of occupational analysis.

Three approaches to occupational analysis were evaluated against a common set of attributes. The three basic approaches are engineering methods, functional job analysis, and the task inventory. No one system is consistently better than the other on all attributes of occupational analysis. No one system

satisfies all possible products for which occupational
analysis is used. However, TI/CODAP (task inventory
with computer assistance) comes closest to meeting the
criteria of good occupational analysis. It also pro-
duces many very useful products such as job evaluation,
manpower planning, and occupational restructuring.
CODAP, the software package developed by the Air Force
Human Resources Laboratory, was reviewed in order to
indicate the kind and range of analyses possible.
Task clustering via CODAP is just one of many useful
applications made possible by this software package.
Task job descriptions based on survey techniques are
one of the basic products of CODAP. This paper attempted
to demonstrate how this form of task analysis is used
by the occupational analyst and manpower planner.

The relevance of the TI/CODAP was discussed and
practical applications were reviewed. Whether for cer-
tification of skills, job description, career ladder
development, or manpower modelling, the TI/CODAP pro-
duces accurate, reliable, and comprehensive job data.

Lastly, personnel assignment modelling was discussed
as a special adaptation of the TI. The creation of a
comprehensive and exhaustive person/position data file
was combined with low cost, accuracy of assignment, and

computerized speed. The MODS[2] (Models for Organiza-
tional Design and Staffing developed by OCMM in asso-
ciated with Carnegie - Mellon University and The
University of Texas at Austin) produces four manage-
ment reports that indicate the optimally assigned
person, all persons by all jobs, all jobs by all per-
sons and a training requirements report. All of these
reports utilize task level data. Also, this system
satisfies EEO, Civil Service, and U.S. Navy regulations.

In sum, the relevance, utility, and comprehensive-
ness of the TI/CODAP seems to offer a significant step
forward over other forms of occupational analysis.
New applications of the TI/CODAP are still being developed
within the Air Force, the Navy, and at major universities.

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[2] If the past fifteen years of continuous research
is any measure, then the prospects for new advances in
the TI/CODAP seems assured.

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A review of the issues concerning the field of occupational analysis
is undertaken in this paper in order to indicate the comparative strengths
and weaknesses of the task inventory.  Specifically, the significance of the
task inventory (TI) will be assessed for:  (1) reliability and validity;
(2) job analysis and evaluation; (3) occupational restructuring and career
ladder development; and (4) manpower planning.  Particular attention is
placed on the Comprehensive Occupational Data Analysis Programs (CODAP)
originally developed by the Air Force as it is applied in the Navy civilian
Models for Organization Design and Staffing (MODS) system.